So we learn that the things in a room warmed by radiation (sunlight or open fire), because they are warmer than the air of the room, do not tend to get very dusty. But in a room warmed by hot piping or stoves, things are liable to get very dusty because the air is warmer than they are.

Finally, let us turn to electrical phenomena in dusty air. Just as a magnet polarises iron filings, and makes them attract each other and point out the lines of force, so an electrified body polarises dust particles, and makes them point out the lines of electrostatic force. It is therefore very interesting to watch electrical phenomena in illuminated smoky air.

The pyroelectric behaviour of tourmaline for instance is beautifully shown by the aggregation of dust in little bushes at the opposite poles of the crystal. Mica often exhibits strong electrical actions But perhaps the most curious thing of all is what happens when a brush discharge begins in such air. The violent and tumultuous action must be witnessed—it can hardly be described; but it does not last long, for in a few seconds every particle of dust has disappeared, condensed on the walls and floor of the vessel.

[An experiment of discharging from a point connected with one pole of a Voss machine into a bell-jar of illuminated magnesium smoke was then shown. It is a very easy experiment, and rather a striking one. A potential able to give quarter-inch or even one-tenth-inch spark is ample, and better than a higher one. The smoke particles very quickly aggregate into long filaments which point along the lines of force, and which drop by their own weight when the electrification is removed. A higher potential tears them asunder and drives them against the sides of the jar. A knob polarises the particles as well as a point, but does not clear the air of them so soon. If the bell-jar be filled with steam, electrification rapidly aggregates the globules into Scotch mist and fine rain.[1]]

This experiment shows how quickly air may be cleared of its solid constituents by a continuous electrical discharge. The fact may perhaps admit of practical application in clearing smoke-rooms, or disinfecting hospital air. It also must have a close bearing on the way in which "thunder clears the air," on thunder-showers, and perhaps on rain in general. Sir Wm. Thomson's "effect of curvature on vapour-tension" shows that large cloud globules increase at the expense of small ones, and so may gradually grow into raindrops; but under electrical influence rapid aggregation of drops must occur. The large drops so formed may be upheld by the electrical attraction of a strongly charged thunder-cloud, but as soon as the flash occurs, down they must come. Lord Rayleigh made some interesting observations on the effect of a feeble electrical charge in inducing a spreading water-jet to gather itself together (*Proc. Roy. Soc.*, No. 221, 1882); and Prof. Tait has pointed out in his lecture on Thunder-storms (NATURE, vol. xxii. pp. 339, 436) that aggregation of feebly charged drops into larger ones is of itself sufficient to raise their potential. One strongly charged cloud would thus act on another, aggregating its drops, and so raising its potential until a flash is a necessity.[2]

It seems not impossible that some use may be made of this aggregating power of electricity on small bodies, such as smoke particles and mist globules. In coming to this country we lay for some hours outside the Straits of Belle Isle in the midst of icebergs mingled with fog. Icebergs alone are not dangerous but beautiful. Fog is an unmitigated nuisance. Electric light is powerless to penetrate it; and it was impossible, as we lay there idle, not to be struck with the advisability of dissipating it. It is rash to predict what can be done, it is still rasher to predict what can not. I would merely point out that on board a steamer are donkey-engines, and that these engines can drive a very powerful Holtz or Wimshurst machine, one pole of which may be led to points on the masts. When electricity is discharged into fog on a small scale, it coagulates into globules and falls as rain—perhaps it will on a large scale too. Oil stills the ripples of a pond, and it has an effect on ocean billows; just so an electric discharge, which certainly coagulates and precipitates smoke or steam in a bell-jar, may possibly have an effect on an Atlantic fog. I am not too sanguine, but it would not cost much to try, and even if it only kept a fairly clear space near the ship, it would be useful. There are other possible applications of this electrical clearing or deposition of dust, but I am not here to talk of practical applications but of science itself. A homely proverb may be paraphrased into a useful motto for young investigators. Stick to the pure science and the applications will take care of themselves. I am not one to decry the applications of science for the benefit of mankind, far from it, but while the rewards of industrial applications are obvious and material, and such as will always secure an adequate following, the rewards of the pursuit of science for its own sake are transcendental and immaterial, and not to be imagined except by the few called to the work. That call entails labour and self-sacrifice beyond most other, but they who receive it will neglect it at their peril.

[1] I find that unless one claims a lecture experiment it is commonly treated as a *rechauffée*. It is pardonable, therefore, and indeed only due to Mr. Clark, who has been associated with me in the dust research, to state that these observations are original. A small cellar can be cleared of thick turpentine smoke pretty quickly by a point discharge.

[2] If the initial potential of the second cloud were opposite to that of the first, the spark would pass between the two clouds: if it were similar, its rise would raise the potential of the first cloud, and so cause it to spark into something else.

HEREDITARY DEAFNESS[1]

THE startling title of Mr. Graham Bell's admirable memoir is fully justified by its contents. It appears that there are upwards of 33,000 deaf mutes in America, mostly collected in large institutions forming social worlds of their own, whose inmates intermarry or else contract marriages with the hearing relatives of their fellow pupils, who themselves, in many cases, must have an hereditary though latent tendency to deafness. This state of things has been going on increasingly for two or more generations, with the result that congenital deafness, which in other countries appears sporadically, and mostly fails to obtain an hereditary footing, has become artificially preserved in America, and is intensified by inter-marriages, until a deaf variety of the human race may be said to be established. There can be no question, after reading the mass of evidence submitted by Mr. Graham Bell, of the general truth of this summary statement. That precise knowledge that we should be glad to possess, of the strength and peculiarity of the hereditary taint, is unfortunately unattainable owing to the imperfection of the records kept at the institutions of the after history of their pupils; but the data, such as they are, have been handled with great statistical skill by the author, so that he has squeezed all the information out of them that they appear competent to give.

We may now go a little more into details. It appears that out of six asylums, with an aggregate of 5323 pupils, 29·5 per cent. have deaf relatives. Also that nearly half the pupils contract marriages, and that 80 per cent. of those who do so, marry together. This ratio of inter-marriage is much greater than it was at the beginning of the century, and it appears to have steadily increased from then up to the present time It is unfortunate that the imperfection of the records kept at the institutions make it difficult to ascertain the exact rate of the increase or the precise fate of the issue of all the marriages. This latter fact may, however, be estimated by working back-

[1] "Upon the Formation of a Deaf Variety of the Human Race," by Alexander Graham Bell, National Academy of Sciences, New Haven, U.S.A., November 13, 1883.

wards, and finding the number of deaf-mutes known to exist among the ancestors of the present inmates of the asylums. The family history of many of these is appalling, such as "Grandfather, father, mother, and other relatives"; "father, mother, one brother, and five uncles and aunts"; two cases of "father, mother, one sister, one uncle, and one aunt"; two cases of "father, mother, two brothers, and two uncles," and so on. In one case as many as fifteen deaf-mute relatives are recorded. Genealogical trees are given of the families in which deaf-mutism prevails, and the large proportion of the members of those families who are congenitally afflicted is most painfully illustrated. The surnames of the inmates of deaf-mute asylums are analysed, and the frequency is pointed out of the recurrence of many strange-sounding names, such as "Fahy," "Hulett," "Closson," "Brasher," "Copher," "Gortschalg," &c., apparently out of all proportion to the number of persons bearing those names in the general population.

The influences that promote the inter-marriage of deaf-mutes are fully described. The isolation of their class from the rest of the world is becoming more and more complete. Each institution is a self-sufficing *alma mater* where every member feels really at home, and with which each member continues his connection in after years. Gatherings of old pupils of both sexes, *conversaziones*, and other social meetings are of frequent recurrence, and what is most important of all, the highly-developed and very conventional gesture language of the deaf and dumb has already moulded them into a distinct nation. They think not in words, but in abbreviated symbolic gestures, and the sequence and association of their ideas is thus compelled to be idiomatic and widely different from those of the rest of their race. English and other spoken languages are foreign tongues to them, and are acquired, for the most part, very imperfectly. A separate mode of life is so congenial to persons reared under such exceptional surroundings, and of such exceptional natures, that unwise schemes have been from time to proposed, of buying land in settlements for the deaf and dumb, where they should reside and form a secluded society of their own. They are content with their lot when they are brought into contact with none but themselves, but they are ill at ease, and feel themselves to be aliens, when they are forced into the presence of the outside world. What wonder that they should shrink from it, and intermarry and strive to keep apart.

The interest of this strange story is twofold. In the first place it shows how easily a marked and degenerate variety of mankind may be established in permanence by a system of selection extending through two or three generations; and, secondly, it is an instance in which strong social, and possibly legislative, agencies are sure to become aroused against unions that are likely to have hereditary effects harmful to the nation. The advisability of various forms of restrictive measures is judiciously and carefully discussed by the author, with the general result that gesture-language should cease to be taught, the oral system being enforced in its place, and that the philanthropic custom of massing the deaf and dumb together in separate societies, and of making their life as happy as possible in those societies, should be strongly discouraged.

Instructive experiments on the rate at which a deaf breed of animals could be formed, might be made by breeding deaf cats, who are by no means inefficient mousers, and who show no signs of discontent at their lot. I may mention an observation of my own as having some possible pathological bearings. It was this: during a country walk I lunched at a roadside inn, where I saw a female cat with blue eyes, and asked and found that she was quite deaf, but was told that her kittens all heard perfectly. The only one of them that had been kept was in the room, and she certainly noticed my voice and other noises I made to attract her attention, just as readily as other kittens. Then it occurred to me to try her with the shrill notes of one of my little whistles, which I had in my pocket-book. She was absolutely deaf to these, and I doubt if she could have heard a note as shrill even as the chirp of a sparrow. Cats, as I have elsewhere observed, are eminently sensitive to shrill notes, so that the deafness of this kitten was a noteworthy proof that the imperfect stages of the form of hereditary deafness to which she was subject consisted in the degeneration of that part of the auditory apparatus which is concerned in hearing shrill notes. I am told that no thorough anatomical investigation has yet been made into these matters, owing to insufficiency of subjects. It would therefore seem that a breed of deaf cats might be very acceptable to physiologists, and I have no doubt that such a breed might be easily established on any small and sparsely-inhabited island from which every hearing cat had been removed. Cats will not breed in strict confinement, and their roving habits at night make it impossible, under ordinary circumstances, to keep their breed pure; but in small islands, under the paternal despotism of a popular landlord, this and many analogous experiments in breeding varieties of small and hardy animals and plants, such, I mean, as would take care of themselves, might be carried out. I have often envied the facilities afforded to such projects by the geographical and social condition of the Scilly Islands.

FRANCIS GALTON

ASTRONOMICAL TELESCOPES FOR PHOTOGRAPHY[1]

II.

THE simplest form of the reflecting telescope is that in which only one reflecting surface is used, known as the Herschelian, or, as Sir John Herschel, in his work, "The Telescope," calls it, "the Simple Reflector." The remarks he makes on this form are well worth most careful consideration in connection with the use of the reflecting telescope for photography.

All other forms have the second or third mirror only for the purpose of bringing the image formed by the large mirror where it can be more conveniently used. Of these the Newtonian is the simplest and perhaps the best, as here the second reflection does not alter the size of the image, but only diverts it to the side of the tube. In the Cassegrain or Gregorian form the use of the convex or concave mirror enlarges the primary image more or less. Modifications of the Cassegrain form can be made by replacing the small convex mirror by a flat or very slightly curved mirror, in which case, although there is much loss of light, the image is kept nearly the same size as in the Newtonian. There is also the "Brachy" form, where the Cassegrain is used obliquely, but this is practically a Cassegrain. In all these telescopes, except the first and last-mentioned, the second mirror requires support of a kind that acts most injuriously on the image, causing rays to come from stars which, in the case of stars as faint as eight magnitude, show quite distinctly with such long exposures as are needed in photographing the nebulæ or clusters of very faint stars. In addition to these well-known forms of the reflecting telescope there is the arrangement of three reflectors as a telescope indicated by me in the May number of the *Monthly Notices* of the Royal Astronomical Society, and also the application of the Coudé principle, treated of at length by M. Lœwy in the June number of the *Bulletin Astronomique* (1884). As far as I know there has not been any practical application of the Coudé principle to the reflector. The need of three reflections would involve great loss of light, and for this reason alone would render it unsuitable for photo-

[1] Continued from p. 40.